

Nasal Carriage of *Staphylococcus aureus* among Pediatric Health Care Workers in a Pediatric Intensive Care Unit

AUTHORS: Pablito M. Planta Jr., MD*, Armi Grace G. Laiño, MD*, Ma. Noreen B. Alqueza, MD*
Ma. Liza M. Gonzales, MD*

*Philippine General Hospital

CORRESPONDENCE:

Dr. Pablito M. Planta, Jr., MD

Email: jojoplantamd@yahoo.com

KEYWORDS

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ABSTRACT

Background/Objective:

An outbreak of nosocomial infections through nasal carriage of organisms by health care workers may also occur. The health care workers (who are in close contact with the patients) are possible sources of hospital-acquired infections. Staphylococci are a leading cause of bacteremia, surgical wound infections and nosocomial infection in many areas around the globe.

The objective of this study was to determine the nasal carriage rate of *Staphylococcus aureus* among health care workers in a pediatric intensive care unit.

Methods: Twenty six healthcare workers in a pediatric intensive care unit of a tertiary hospital were included. Cultures from the anterior nares were obtained using a sterile cotton tip swab, which was moistened with sterile normal saline solution. Samples were then analyzed using standard microbiological methods. The susceptibilities of the isolates to antibiotics were then determined by the Kirby Bauer disk diffusion method. Nasal carriage rate of *Staphylococcus aureus* was determined.

Results: The mean age of the subjects was 35 years (range 22-56) old. There were 20 nurses (76.9%), 4 (15.4%) nurse assistants, and 2(7.7%) utility workers; 3 (11.5%) were males and 23 (88.5%) were females. Two subjects (7.7%) grew *Staphylococcus aureus*. Both reported 100% sensitivity to all tested antibiotics except for Penicillin G which showed 100% resistance. Twenty four of the subjects (92.3%) grew *Staphylococcus epidermidis*, 5 (20.83%) were methicillin resistant. All showed 100% sensitivity to Gatifloxacin, Levofloxacin, Oxacillin, and Vancomycin. There was high resistance (62.5%) to Penicillin G.

Conclusion: The nasal carriage rate (7.7%) of *Staphylococcus aureus* in this study is lower compared to earlier reports. The results of this study showed higher nasal carriage of *Staphylococcus epidermidis* (92.3%).

INTRODUCTION

The nosocomial infection rate in the Philippine General Hospital remains high; this becomes a significant hazard to patients. The health care workers (physicians, medical students, nurses, nurse assistants, utility workers, etc.), who are in close contact with the patients are possible sources of such hospital-acquired infection, with many of the pathogenic organisms transmitted by hand carriage: This is the rationale behind the recommendation for everyone to practice proper hand washing before and after examining patients. It has been established that strict compliance to hand washing reduces hospital-acquired infections. However, an outbreak of nosocomial infections through nasal carriage of organisms by health care workers is also a possibility.

Staphylococci are the leading cause of bacteremia, surgical wound infections, and infections of bioprosthetic materials in the United States; they are the second leading cause of nosocomial infections overall. *Staphylococcus aureus* is the most important human pathogen in the genus. Despite the availability of potent antimicrobial agents, improved public health conditions, and hospital-infection control measures, it has remained a major human pathogen.¹ Carriage of *Staphylococcus aureus* plays a key role in the epidemiology and pathogenesis of infection because of both the diversity and the severity of the infections caused by this organism. It is also a major risk factor for the development of both community-acquired and nosocomial infections.^{2, 6}

In U.S. hospitals in the National Nosocomial Infections Surveillance System, *Staphylococcus aureus* accounted for 13% of isolates recovered from patients with nosocomial infections from 1979 to 1995; the percentage has increased in recent years. Multidrug-resistant strains of *Staphylococci* had been reported with increasing frequency worldwide, including isolates that were resistant to methicillin, lincosamides, macrolides, aminoglycosides,

fluoroquinolones, or combinations of these antibiotics. The severe consequences of infection with *Staphylococcus aureus* heightened the importance of prevention.³

Several studies have documented that these infections were commonly caused by the patient's own commensal flora. The original reservoir(s) from which patients acquire these isolates remained unclear. While some infected patients were colonized with *Staphylococcus aureus* at the time of hospitalization, others likely became colonized, often with more highly antibiotic-resistant isolates, during their hospital stay.¹ Hospital personnel were among those implicated as possible sources of the potentially antibiotic-resistant pathogens. Transmission of the pathogens to patients was then likely to occur during routine patient care. Despite the possible importance of this sequence of events, the questions of whether health care workers are more likely to be colonized with *Staphylococcus aureus* and if these organisms reflect those found in the hospital setting, have received limited attention in the local setting, thus this study.

This study determined the nasal carriage rate of *Staphylococcus aureus* among pediatric healthcare workers in the Philippine General Hospital Pediatric Intensive Care Unit.

MATERIALS AND METHODS

Study Population

Pediatric health care workers (physicians, nurses, nurse assistants, utility workers, etc.) at the Philippine General Hospital Pediatric Intensive Care Unit were included in the study. Healthcare workers who were on antibiotics, on intranasal corticosteroids, and those with current upper respiratory tract infections were excluded.

Cultures from the anterior nares were obtained from all the subjects after an 8-hour duty using a sterile cotton tip swab moistened with sterile normal saline solution (0.9%). The nares was chosen for sampling because it was the native colonization site for staphylococci and usually represented colonization rather

than transient skin coverage.¹³ The swabs were inoculated using blood agar plates and incubated for 24 to 48 hours. Samples were then analyzed using standard microbiological methods.

The susceptibilities of the isolates to 11 antibiotics (cefazolin, chloramphenicol, ciprofloxacin, erythromycin, gatifloxacin, levofloxacin, oxacillin, penicillin, tetracycline, trimethoprim-sulfamethoxazole, and vancomycin) were determined by the Kirby Bauer disk diffusion method according to the National Committee for Clinical Laboratory Standards' guidelines.

The results of the cultures were collected and tabulated according to the frequency of positive cultures in each category, and the sensitivity and resistance of *Staphylococcus aureus* and *Staphylococcus epidermidis* to the most frequently used antibiotics in clinical practice.

Statistical Analysis

Sample size estimate for a single proportion was computed at 26 with 95% confidence level. Analysis and data interpretation was done by the investigator. Frequencies were obtained and percentages were calculated by study variables.

RESULTS

A total of 26 subjects from among the 35 rotating in the pediatric intensive care unit were included in this study. Three did not give their consent while 6 were on leave. The mean age of the subjects was 35 years (range 22-56)—with years in service ranging from 1 month to 25 years. Subjects included 20 nurses (76.9%), 4 (15.4%) nurse assistants, and 2 utility workers (7.7%). According to sex distribution pattern, 3 (11.5%) were males and 23 (88.5%) were females.

Table 1. Demographic data of pediatric health care workers in the PGH-PICU

Category	Male (%)	Female (%)	Total (%)
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Nurses	1 (5)	19 (95)	20 (76.9)
Nurse Assistants	0	4 (100)	4 (15.4)
Utility Worker	2 (100)	0	2 (7.7)
Total	3 (11.5)	23 (88.5)	26 (100)

***Staphylococcus aureus* carriers**

Of the 26 subjects, two (7.7%) grew *Staphylococcus aureus*. Table 2 contains details on the nasal carriage rates of *Staphylococcus aureus* among subjects in the different categories. *Staphylococcus aureus* was isolated in 2 (1%) nurses out of the 20 that were included in the study. The nurse assistants and utility workers were clear of nasal carriage.

Table 2. Nasal carriage of *Staphylococcus aureus* among pediatric healthcare workers in the PGH-PICU

Category	Subject	No. with <i>S. aureus</i>	%
Nurses	20	2	1
Nurse Assistants	4	0	0
Utility Worker	2	0	0
Total	26	2	7.7%

This study also showed the growth of *Staphylococcus epidermidis* in 24 of the subjects, which accounted for 92.3%; There were 18 (90%), 4 (100%) and 2 (100%) from the nurses, nurse assistants and utility workers, respectively. The resistance pattern is showed in Table 5.

Table 3. Nasal carriage of *Staphylococcus epidermidis* and MRSE among health care workers in PGH-PICU

Category	Subject	No. with <i>S. epidermidis</i> (%)	No. with MRSE (%)
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Nurses	20	18 (90)	4
Nurse Assistants	4	4 (100)	(22.2)
Utility Workers	2	2 (100)	1 (25)
Workers			0
Total	26	24 (92.3)	5 (20.8)

Antimicrobial susceptibility studies of *Staphylococcus aureus* isolates by the Kirby-Bauer disc diffusion methods showed 100% sensitivity to all tested antibiotics, except for penicillin G, which showed 100% resistance.

With regards to the antimicrobial sensitivity and resistance profile of *Staphylococcus epidermidis* isolates, 100% of the isolates were sensitive to gatifloxacin, levofloxacin, oxacillin, and vancomycin. Ciprofloxacin showed 87.5% sensitivity and 12.5% resistance. Both Chloramphenicol and tetracycline showed 83.33% sensitivity and 16.6% resistance, while both trimethoprim sulfamethoxazole and cefazolin showed 75% sensitivity and 25% resistance. Erythromycin has 66.66% sensitivity and 33.33% resistance. An important finding in Table 5 showed a high resistance (62.5%) of *Staphylococcus epidermidis* to penicillin G, but with low sensitivity (37.5%).

Table 4. Antibiotic sensitivity and resistance pattern of *Staphylococcus aureus* (N=2)

Antibiotic	Sensitive (%)	Resistant (%)
Cefazolin	2 (100)	0
Chloramphenicol	2 (100)	0
Ciprofloxacin	2 (100)	0
Erythromycin	2 (100)	0
Gatifloxacin	2 (100)	0
Levofloxacin	2 (100)	0
Oxacillin	2 (100)	0
Penicillin G	0	2(100)
Tetracycline	2 (100)	0
Cotrimoxazole	2 (100)	0
Vancomycin	2 (100)	0

DISCUSSION

It has often been suggested that certain strains of *Staphylococcus aureus* have a special ability to colonize hospital staff¹⁴: They colonize the anterior nares and moist body areas of humans. The anterior nares have been shown to be the main reservoir of *Staphylococcus aureus* in adults and children. Nasal carriage of *Staphylococcus aureus* has been demonstrated to be a significant risk factor for nosocomial and community-acquired infections in a variety of populations.¹⁵ There is paucity of information on the nasal carriage of *Staphylococcus aureus* among pediatric health care workers in the pediatric intensive care unit and its importance in *Staphylococcus aureus* spread. In this study, the nasal carriage rate of *Staphylococcus aureus* among health care workers in the pediatric intensive care unit and its susceptibility and resistance profile were studied.

Table 5. Antibiotic sensitivity and resistance pattern of *Staphylococcus epidermidis* (N=24)

Antibiotic	Sensitive (%)	Resistant (%)
Cefazolin	18 (75)	6 (25)
Chloramphenicol	20 (83)	4 (17)
Ciprofloxacin	21 (88)	3 (12)
Erythromycin	16 (67)	8 (33)
Gatifloxacin	20 (100)	0
Levofloxacin	20 (100)	0
Oxacillin	20 (100)	0
Penicillin G	9 (38)	15 (62)
Tetracycline	20 (83)	4 (17)
Cotrimoxazole	18 (75)	6 (25)
Vancomycin	20 (100)	0

The organism may be transmitted from the nose to the skin, where colonization seemed to be more transient. Person-to-person transmission was the usual mode of spread occurring via the hands, nasal discharges, and rarely by aerosol.¹⁶ Mucin appeared to be the critical surface that was colonized in a process involving interactions between staphylococcal

protein and mucin carbohydrate. The role of interference by other commensal bacteria, secretory IgA, or specific staphylococcal adhesions was unknown.³

As in previous investigations done, this study revealed a reservoir of asymptomatic *Staphylococcus aureus* colonized healthcare workers. The result of the surveillance cultures done in this investigation showed that 7.7 % of the pediatric intensive care unit personnel were carriers of *Staphylococcus aureus*. In previous studies done, the colonization rate of *Staphylococcus aureus* carriage may range from 14% – 45%. The result could mean that the nasal carriage rate of *Staphylococcus aureus* was lower compared to earlier reports. Though it was low, pediatric intensive care unit personnel found to be *Staphylococcus aureus* carriers in their anterior nares were possible causes of its spread.

From the results, it can be seen that aside from *Staphylococcus aureus*, most of the isolates showed growth of *Staphylococcus epidermidis*. *Staphylococcus epidermidis*, often previously dismissed as culture contaminants, were now assuming greater importance as true pathogens.¹ In recent years, *Staphylococcus epidermidis*, one of the staphylococcal species most frequently isolated from the microflora of humans, has emerged as a major pathogen in nosocomial infections; Of the *S. epidermidis* strains circulating in the hospital environment, as many as 70% can be resistant to methicillin. The establishment of methicillin-resistant *S. epidermidis* (MRSE as resident flora in the hospital environment was worrisome since these strains, which were predominantly involved in nosocomial infections can accumulate resistance-determinants to practically all classes of antimicrobials. These strains were also potentially transferable to *S. aureus* and other microorganisms.¹⁷

Today, with the global issue of multidrug-resistant bacteria, there is every reason to consider the possibility of MRSE as a true pathogen and not just a mere contaminant. The existence of nasal carriers of, MRSE, their

identification, and the significance of their presence in the PICU, have not been investigated well before. The nasal carriage rate of MRSE in this study (20.83%) corresponds to the study done by Tammelin A, et al, on dispersal of MRSE by staff in an operating suite for thoracic and cardiovascular surgery. Said study showed nasal carriage rate of 28 % in women and 33% in men²³. It was not clear whether MRSE should be regarded as part of the normal resident flora of human skin, in the same way as methicillin-sensitive *S. epidermidis*, or as a transient skin contaminant. This probably depends on which population is studied: hospital staff spending several hours a day in an environment where the selection of resistant bacterial strains is favored or healthy individuals without hospital contacts.

One interesting finding to note was the high sensitivity rate (100%) of *Staphylococcus aureus* to Oxacillin despite worldwide reports of its high resistance rate to this drug, especially in the hospital setting. Navarro-Almario et. al., in 1987, did a review of the antibiotic susceptibility pattern of *Staphylococcus aureus* isolates at the Philippine General Hospital. Out of the 213 isolates shown to be oxacillin-resistant by disc diffusion method, only 3 (2.3%) were confirmed to be truly resistant by MIC.¹ The study by Ontengco et. al. on Methicillin-resistant *Staphylococcus aureus* isolates from Filipino patients (1999-2003), which showed high resistance (87.1-96.1%) to Penicillin and *Staphylococcus aureus* strains remained highly susceptible to erythromycin, levofloxacin, ciprofloxacin, tetracycline, vancomycin, and cotrimoxazole.²¹ Oxacillin resistance in this study was 18%.

Unfortunately, the latest Antimicrobial resistance surveillance in the Philippines shows an increasing trend of MRSA, with 2010 data showing Oxacillin resistance at 54%. Thus it would be important to revisit the nasal carriage of health workers in the present decade to see if it reflects the present MRSA resistance in the Philippines

CONCLUSION

This study suggests that *Staphylococcus aureus* nasal colonization is present among pediatric healthcare workers in the Philippine General Hospital and that the nasal carriage rate (7.7%) is low compared to previous studies done locally and internationally. If the pediatric intensive care personnel are identified as vectors of transmission, their isolates are likely to reflect the antibiotic susceptibility profile prevalent in the area.

An important finding is the high antibiotic sensitivity to Oxacillin. However, a high resistance rate (100%) to Penicillin G was noted. The *Staphylococcus aureus* remained highly susceptible (100%) to Cefazolin, Chloramphenicol, Ciprofloxacin, Erythromycin, Gatifloxacin, Levofloxacin, Tetracycline, Cotrimoxazole, and Vancomycin.

The results also showed that nasal carriage of *Staphylococcus epidermidis* is even higher compared to *Staphylococcus aureus* and has high resistance (62.5%) to Penicillin G.

RECOMMENDATION

This study however involved only a single area, so an intradepartmental surveillance is recommended to determine the true nasal carriage rate of *Staphylococcus aureus* among pediatric health care workers of the Philippine General Hospital.

It is necessary to have a reliable system of surveillance not just for patients but for personnel as well.

LIMITATIONS OF THE STUDY

This study was conducted among pediatric healthcare workers at the Pediatric Intensive Care Unit of the Philippine General Hospital and did not include other pediatric healthcare workers in the different areas of the Department of Pediatrics. Data gathering was done during the month of October 2005. All other personnel at the PICU during the time of the study who were on leave were excluded.

RECOMMENDATIONS

It is recommended that antibiotic resistance surveillance be continually monitored for trends in resistance. Likewise, the clinical outcomes of the UTI after completion of treatment should also be studied.

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